

FIG. 1A

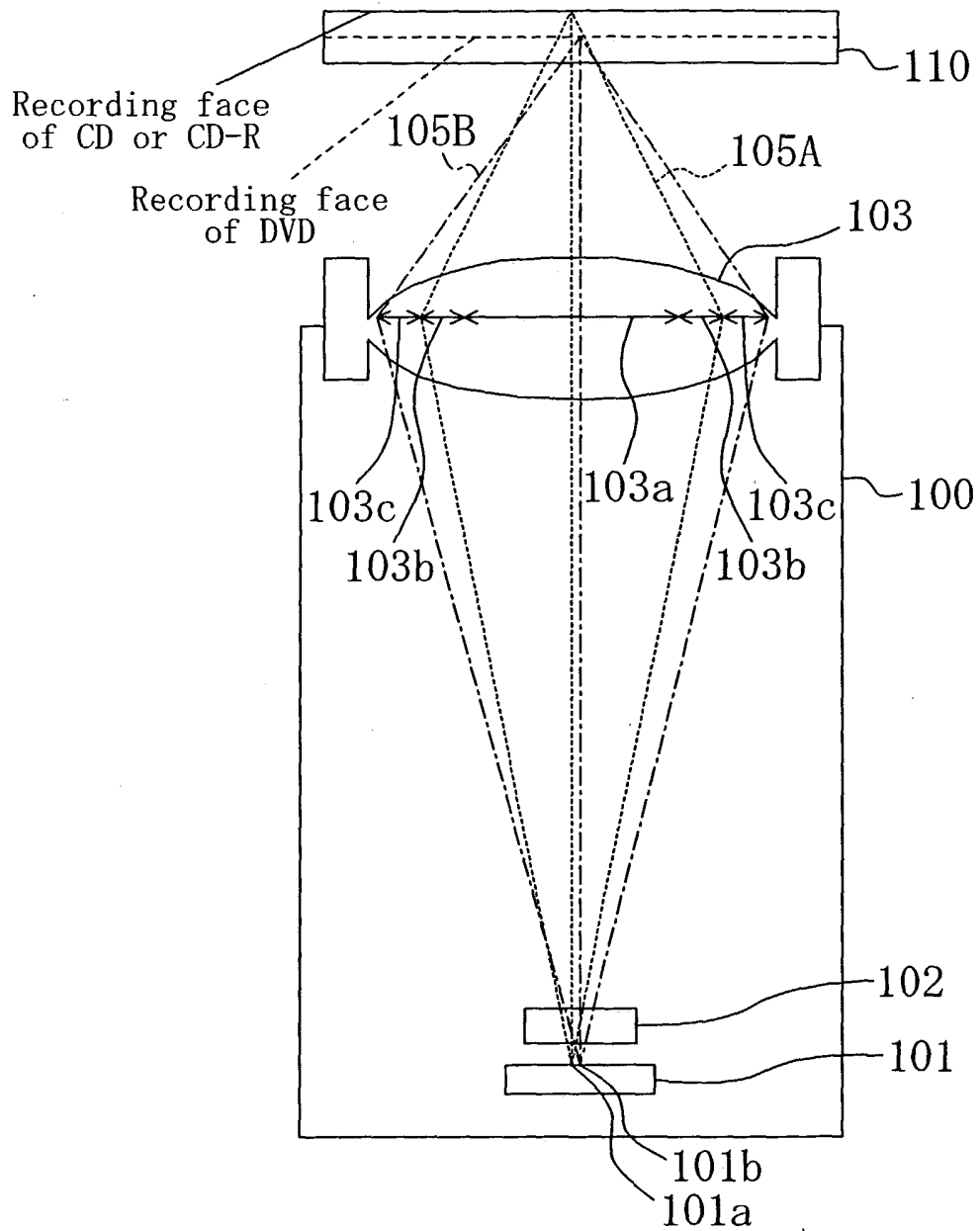


FIG. 1B

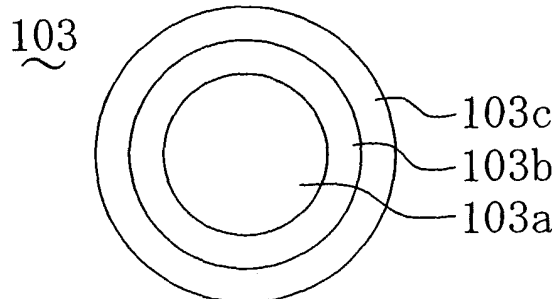


FIG. 2A

	Focal length		Effective diameter R1 ϕ		Effective diameter R2 ϕ	
	DVD	CD	DVD	CD	DVD	CD
Design example 1	2.103	2.116	3.05	2.24	2.69	1.79
Design example 2	2.307	2.319	3.26	2.41	2.72	1.83

	TT		OD		CT		WD	
	DVD	CD	DVD	CD	DVD	CD	DVD	CD
Design example 1	18.724	18.963	15.254	15.254	1.570	1.570	1.300	0.938
Design example 2	20.418	20.657	16.358	16.358	2.159	2.159	1.300	0.939

FIG. 2B

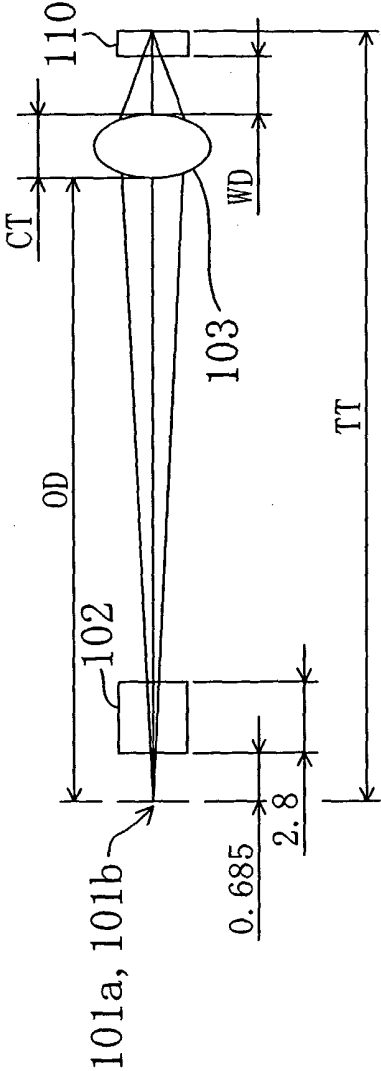


FIG. 3

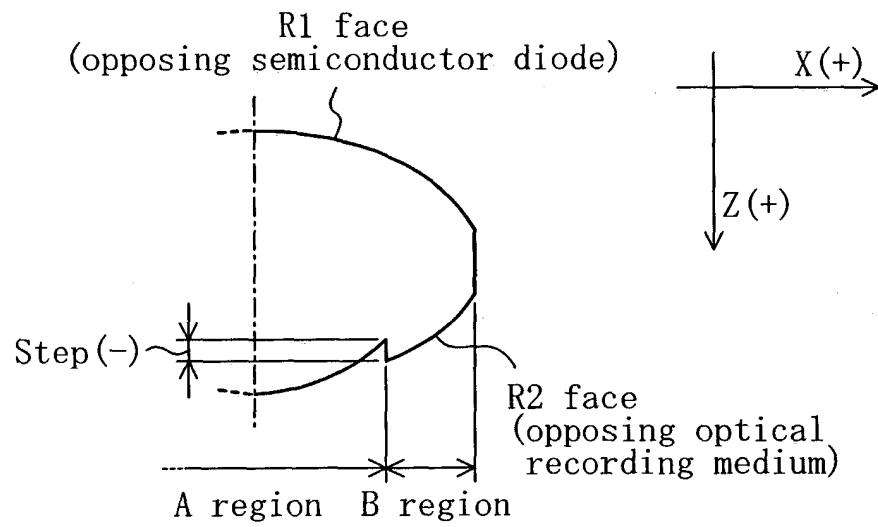


FIG. 4

	Region for DVD and CD	Region for CD (partly including region for DVD)	Region for DVD
	R1 face	R2 face (A region)	R2 face (B region)
Center thickness (mm)	1.57026	----	----
Effective (region) diameter (ϕ) (mm)	3.050	1.787	2.692
Curvature (R) (mm)	1.47929	- 2.81207	- 2.79098
K	- 1.24492	0.00000	0.00000
A_4	$1.91049E \times 10^{-2}$	$6.57018E \times 10^{-2}$	$7.06736E \times 10^{-2}$
A_6	$2.92900E \times 10^{-3}$	- $1.33152E \times 10^{-2}$	- 1 $.35424E \times 10^{-2}$
A_8	$3.53749E \times 10^{-4}$	$2.43982E \times 10^{-3}$	$1.42971E \times 10^{-3}$
A_{10}	$0.00000E \times 10^0$	$0.00000E \times 10^0$	$0.00000E \times 10^0$
Step (mm)	----	- 0.001481	

FIG. 5

	Region for DVD and CD	Region for CD (partly including region for DVD)	Region for DVD
	R1 face	R2 face (A region)	R2 face (B region)
Center thickness (mm)	2.159346	----	----
Effective (region) diameter (ϕ) (mm)	3.252	1.826	2.714
Curvature (R) (mm)	1.7036	- 2.39375	- 2.38194
K	- 1.272987	0.00000	0.00000
A ₄	$7.16899\text{E} \times 10^{-3}$	$5.58818\text{E} \times 10^{-2}$	$5.95038\text{E} \times 10^{-2}$
A ₆	$5.24988\text{E} \times 10^{-4}$	- $1.36935\text{E} \times 10^{-2}$	- $1.26669\text{E} \times 10^{-2}$
A ₈	- $2.76338\text{E} \times 10^{-4}$	$3.34402\text{E} \times 10^{-3}$	$1.85528\text{E} \times 10^{-3}$
A ₁₀	$0.00000\text{E} \times 10^0$	$0.00000\text{E} \times 10^0$	$0.00000\text{E} \times 10^0$
Step (mm)	----	- 0.001422	

FIG. 6A

Design example 1: Optical path for DVD

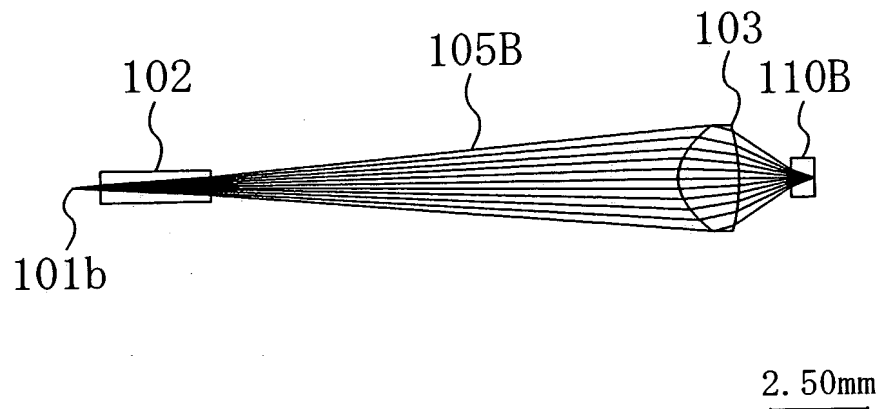


FIG. 6B

Design example 1: Optical path for CD

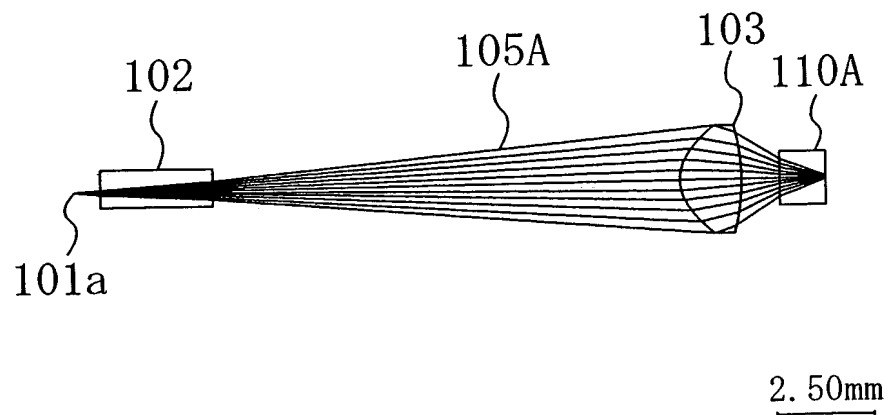


FIG. 7A

Design example 2: Optical path for DVD

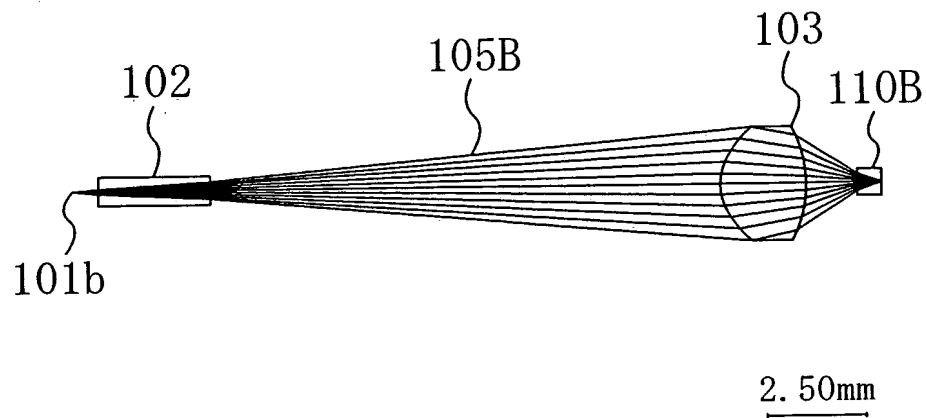


FIG. 7B

Design example 2: Optical path for CD

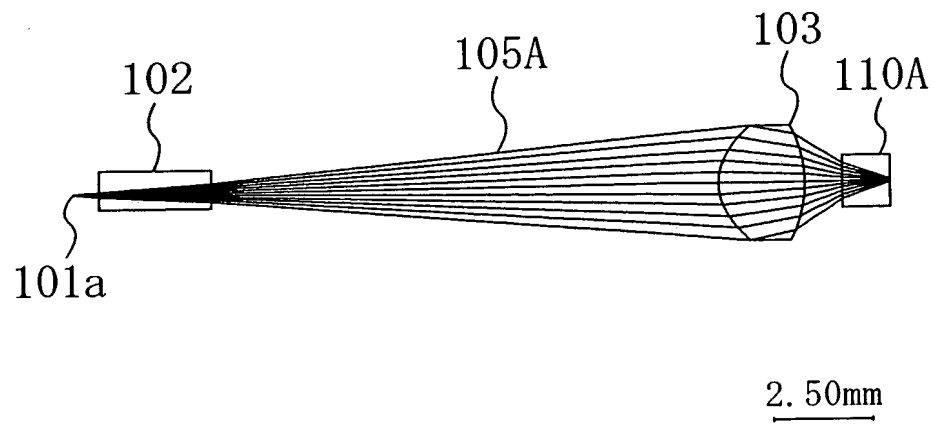


FIG. 8

	Optical magnification	
	DVD	CD
Design example 1	- 0.167	- 0.168
Design example 2	- 0.167	- 0.168

FIG. 9A

Design example 1: For DVD

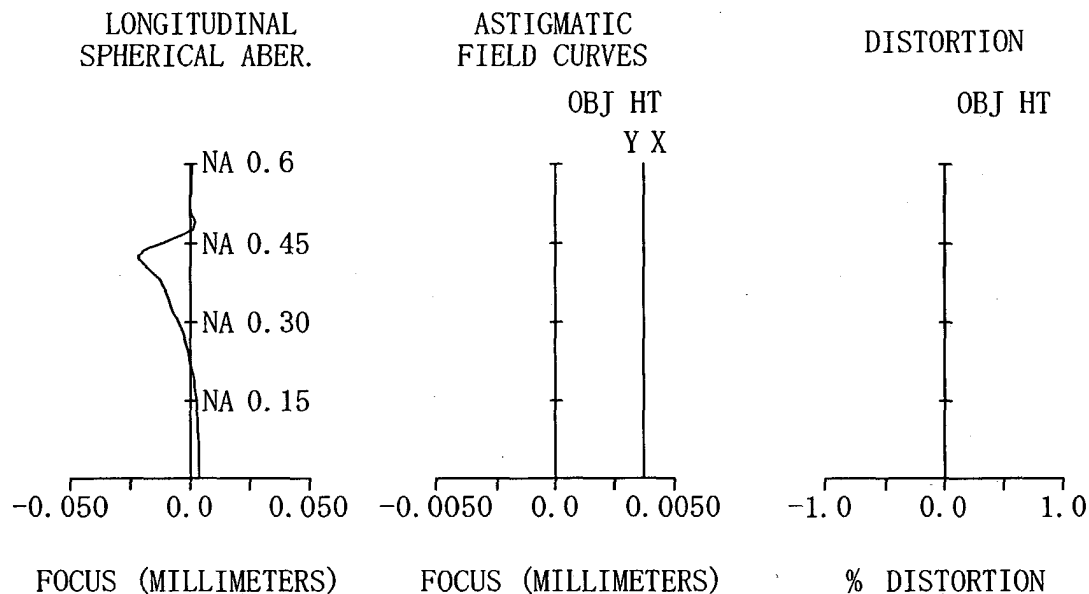


FIG. 9B

Design example 1: For CD (numerical aperture not limited)

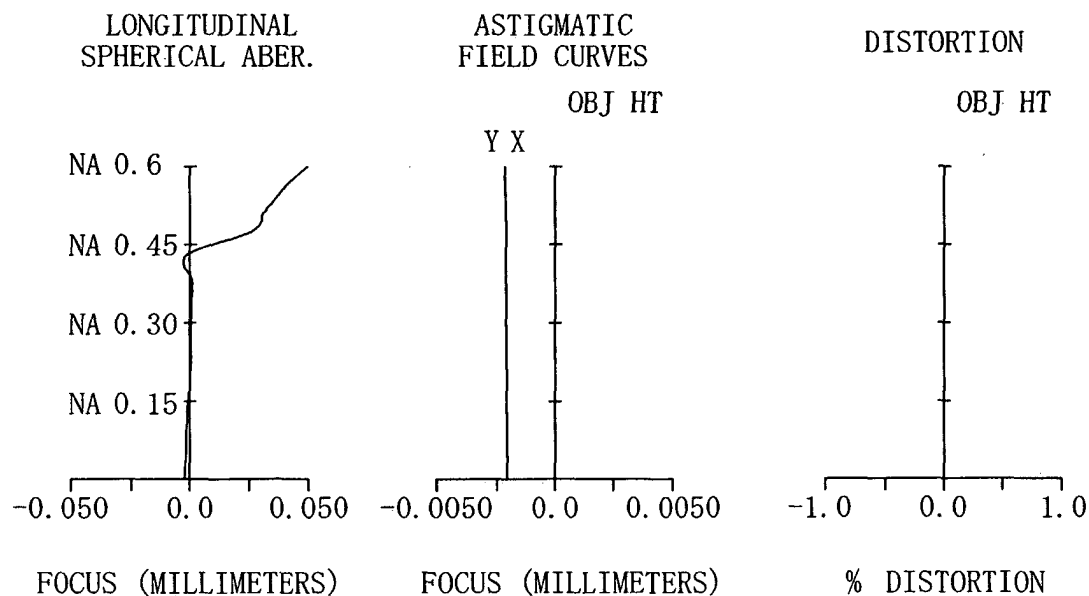


FIG. 10A

Design example 2: For DVD

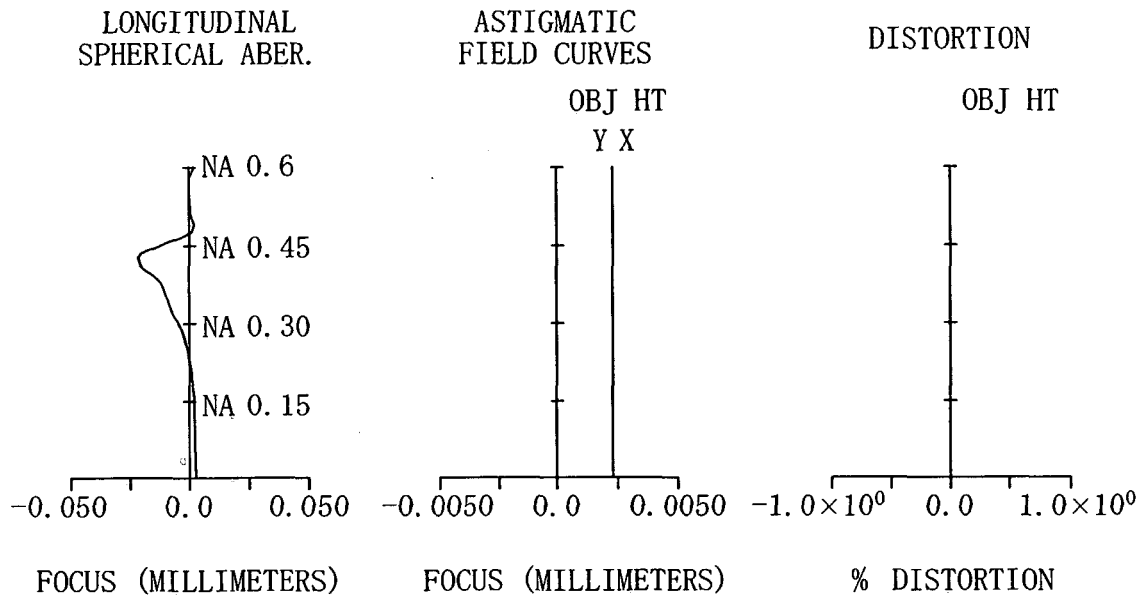


FIG. 10B

Design example 2: For CD (numerical aperture not limited)

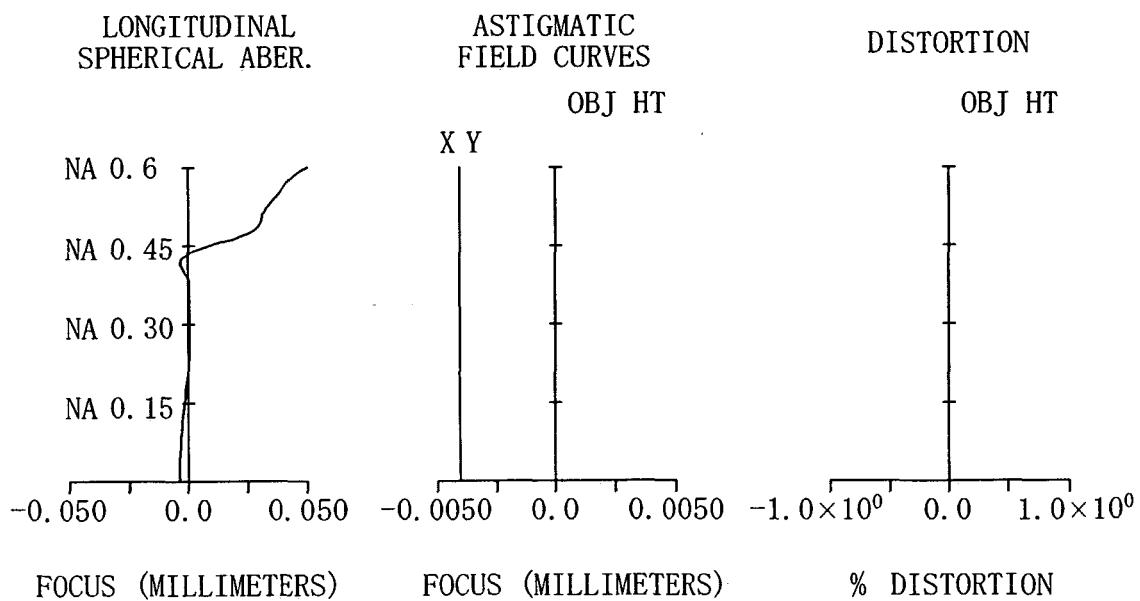


FIG. 11A

Design example 1:

Point image intensity distribution in DVD

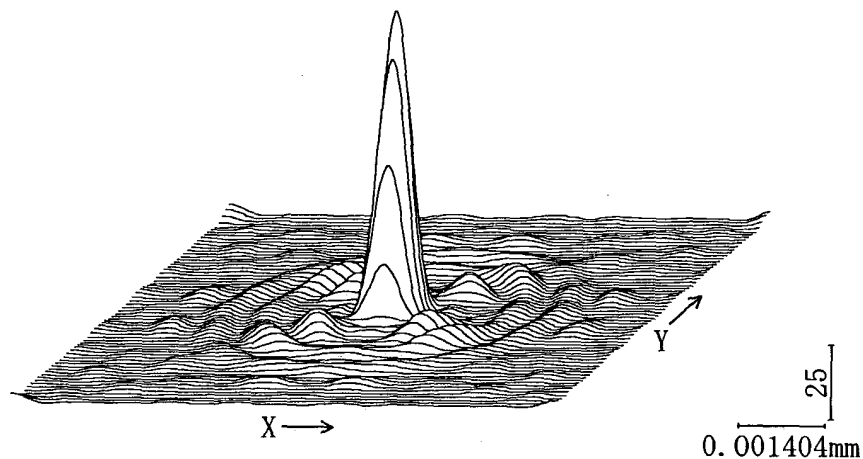


FIG. 11B

Design example 1:

Point image intensity distribution in CD

(Numerical aperture not limited)

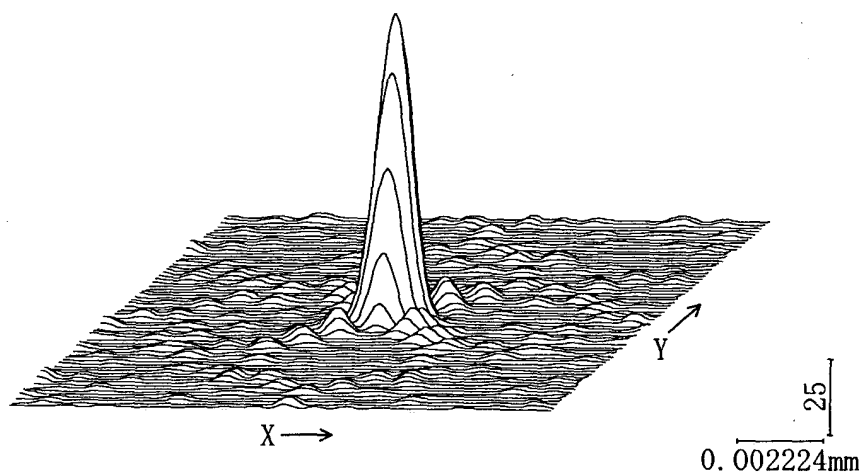


FIG. 11C

Comparative design example:

Point image intensity distribution in CD

(Numerical aperture not limited)

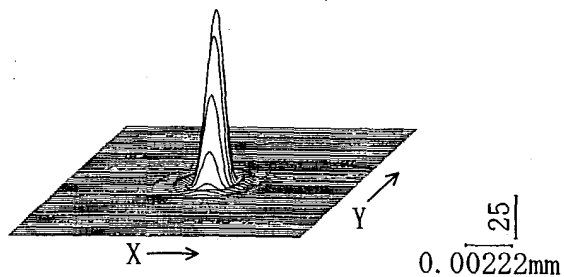


FIG. 12A

Design example 2:

Point image intensity distribution in DVD

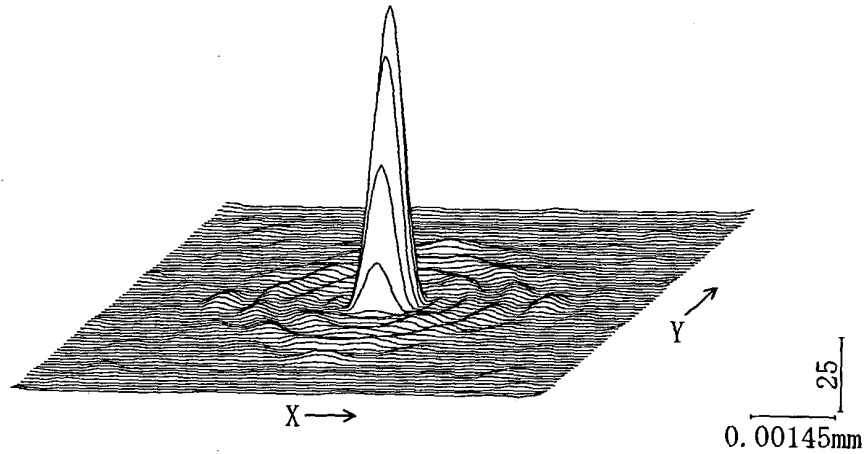


FIG. 12B

Design example 2:

Point image intensity distribution in CD

(Numerical aperture not limited)

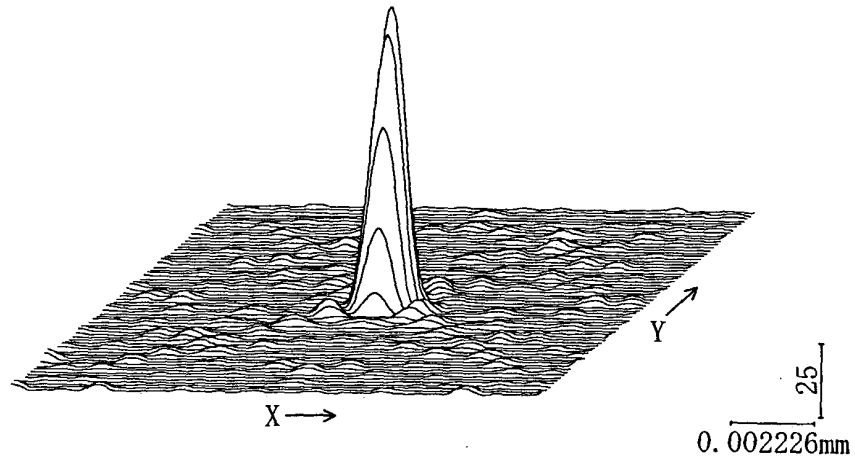


FIG. 12C

Comparative design example:

Point image intensity distribution in CD

(Numerical aperture not limited)

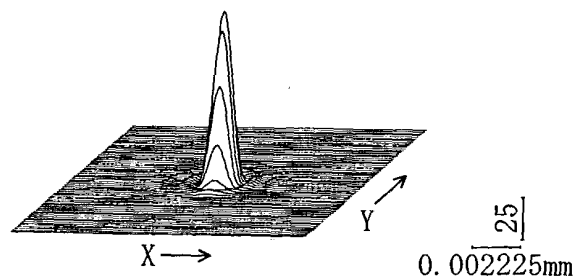


FIG. 13

	Spot diameter(μ m) Numerical aperture not limited			Spot diameter(μ m) Numerical aperture limited			Side robe(%)		
	DVD	CDX	CDY	CDX	CDY	DVD	CD	CD Numerical aperture limited	
Design example 1	0.897	1.406	1.437	1.455	1.450	3.25	3.17	1.86	
Design example 2	0.912	1.445	1.448	1.441	1.449	2.23	2.36	2.06	

FIG. 14A

Masking for
lens for DVD
(shielding portion)

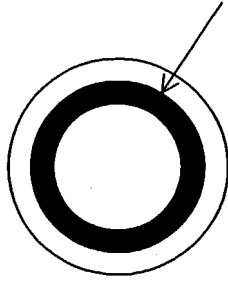


FIG. 14B

Masking for
lens for CD
(shielding portion)

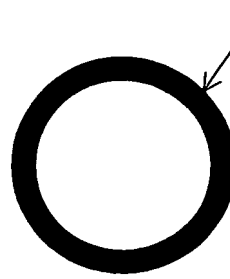


FIG. 14C

		Wave aberration (λ RMS)	Spot diameter (μ m)	Side robe (%)
DVD	With mask	0.0172	0.89×0.89	2.47
	Without mask	0.3325	0.89×0.89	2.30
CD	With mask	0.0066	1.45×1.45	1.79
	Without mask	1.5278	1.44×1.45	1.79

FIG. 14D

		Wave aberration (λ RMS)	Spot diameter (μ m)	Side robe (%)
DVD	With mask	0.0238	0.90×0.90	1.37
	Without mask	0.1941	0.91×0.91	1.37
CD	With mask	0.0265	1.46×1.47	2.12
	Without mask	1.3776	1.43×1.40	2.05

FIG. 15

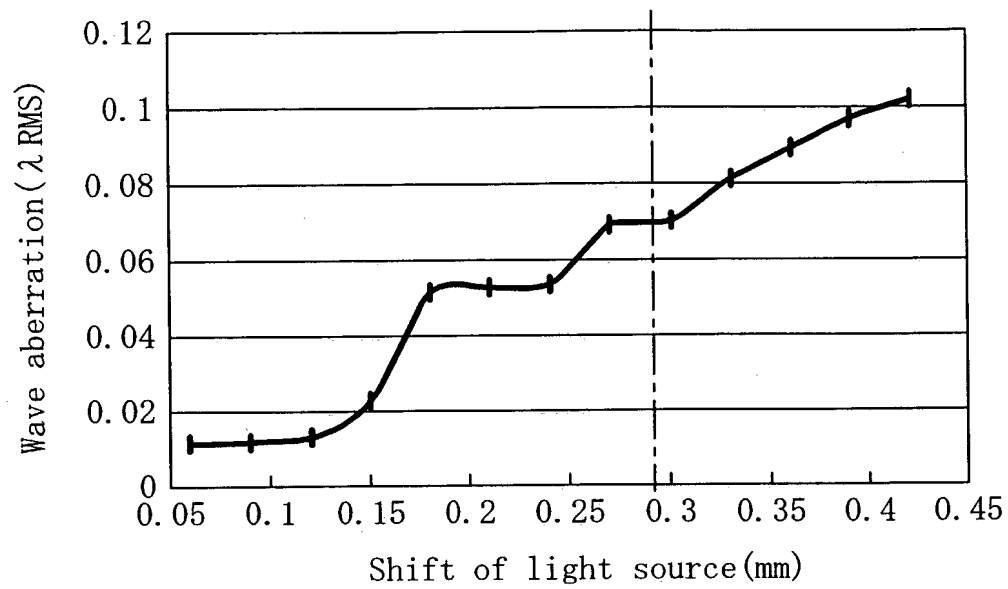


FIG. 16A

PRIOR ART

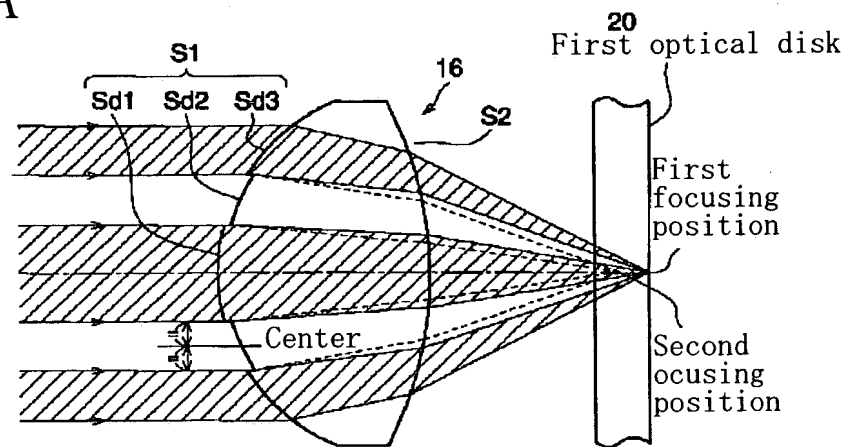


FIG. 16B

PRIOR ART

